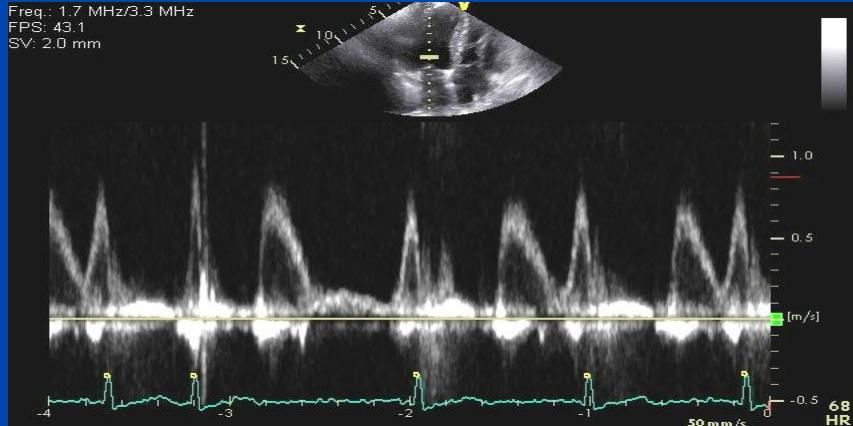


Question #1

Choose the grading of diastolic function in 82 yo woman
 $E = 80 \text{ cm/s}$ $A = 70 \text{ cm/s}$ LAVI $< 34 \text{ mL/m}^2$

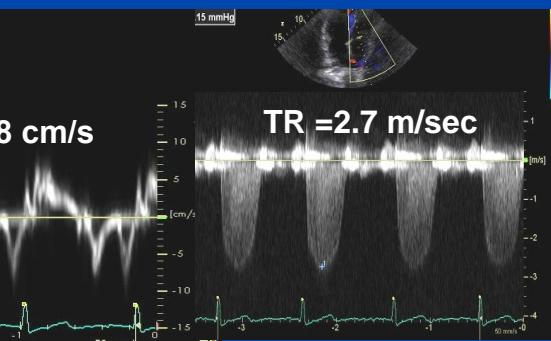
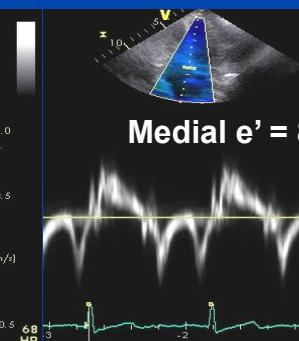
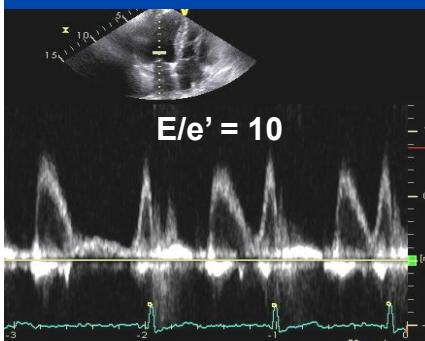


1= Grade 1 2= Grade 2 3= Grade 3 4= Normal 5= Indeterminate



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Choose the grading of diastolic function in 82 yo woman
 $E = 80 \text{ cm/s}$ $A = 70 \text{ cm/s}$ LAVI $< 34 \text{ mL/m}^2$



1= Grade 1 2= Grade 2 3= Grade 3 4= Normal 5= Indeterminate



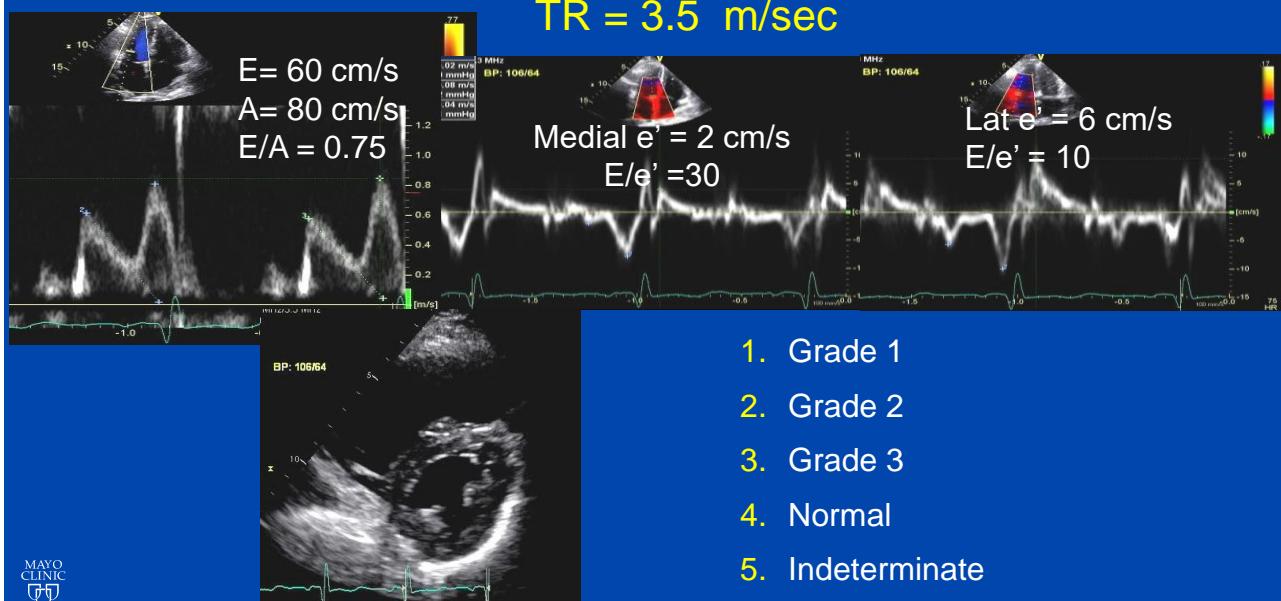
©2018 MFMER | 3712003-2

82 year old woman with normal diastolic function



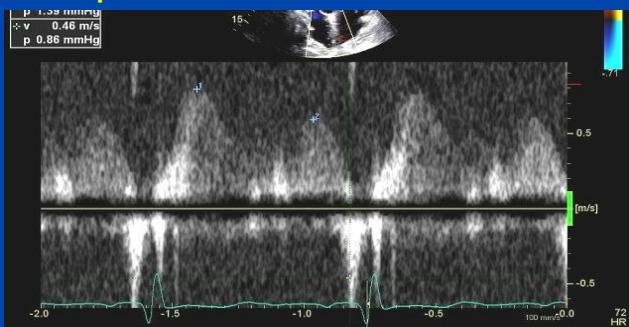
Question #2

Grade diastolic function in 80 YO man with dyspnea
 $TR = 3.5 \text{ m/sec}$



1. Grade 1
2. Grade 2
3. Grade 3
4. Normal
5. Indeterminate

80 YO man with dyspnea
Septal e' is reduced due to PHT



1. e' is reduced
2. E/e' +/-
3. LAVI normal
4. TR is high



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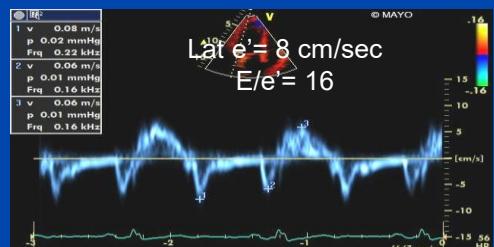
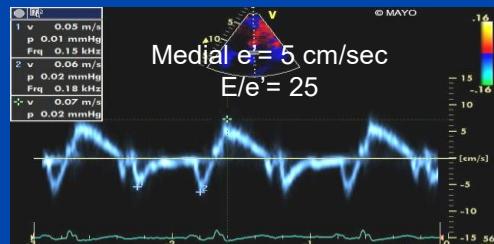
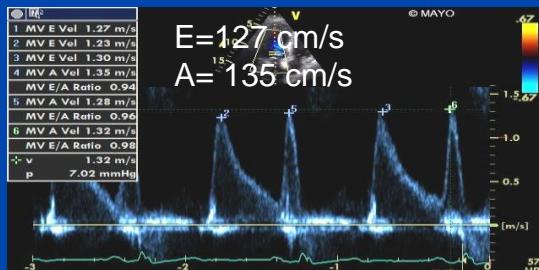
80 year old man with dyspnea and PHT
Cardiac Cath Data

- RA pressure 2 mmHg
- RVSP 50 mmHg
- Mean PASP 28 mmHg
- PCWP 4 mmHg
- LVEDP 13 mmHg
- Cardiac Index 1.5 L/min/m²

Diastolic Function in 65 yo man with hypertension ?

Question #3

LAVI = 20 mL/m² & TR = 3 m/s



1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate

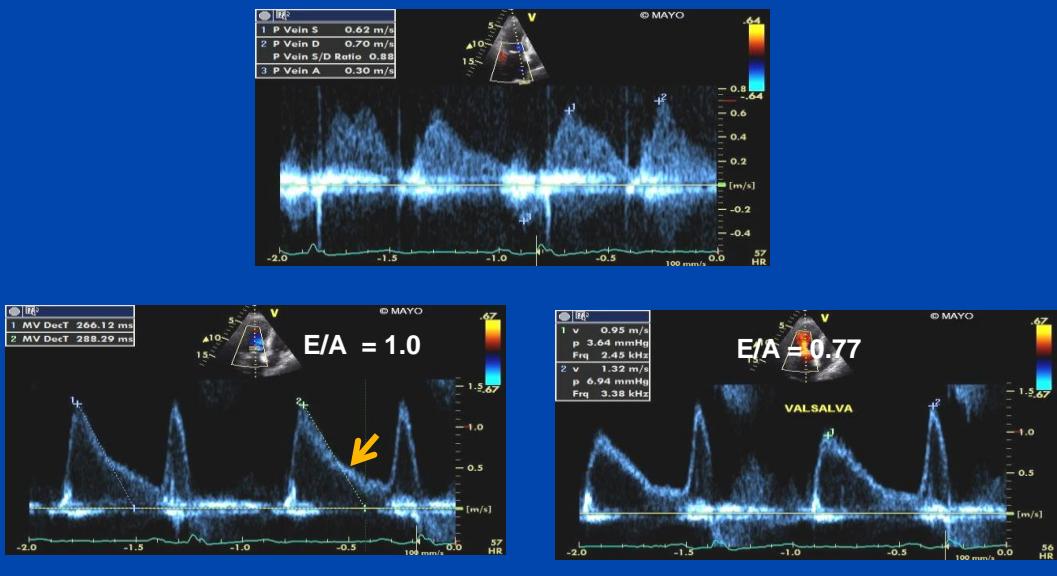


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LV volume measurement



65 yo man with hypertension



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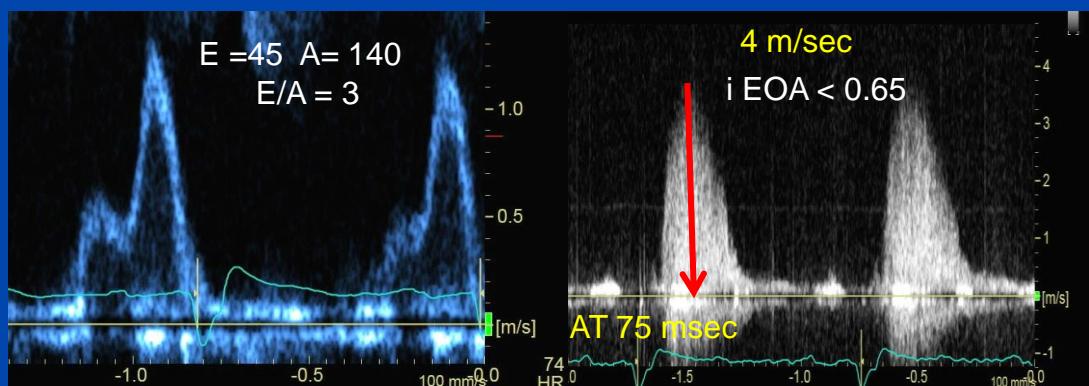
Good Quality in Measurements is the Key!
No data is better than wrong data !

78 yo woman with 21 mm CE AVR 2010 for severe AS
Referred for Valve in Valve with high gradient and dyspnea



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78 yo female with 21 mm CE AV prosthesis and SOB
How do you grade her diastolic function?

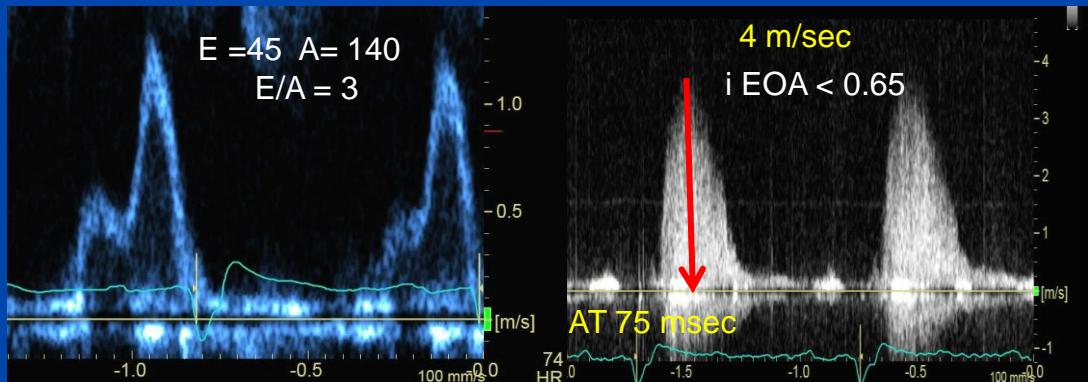


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate



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78 yo female with 21 mm CE AV prosthesis and SOB
What is your next diagnostic step?

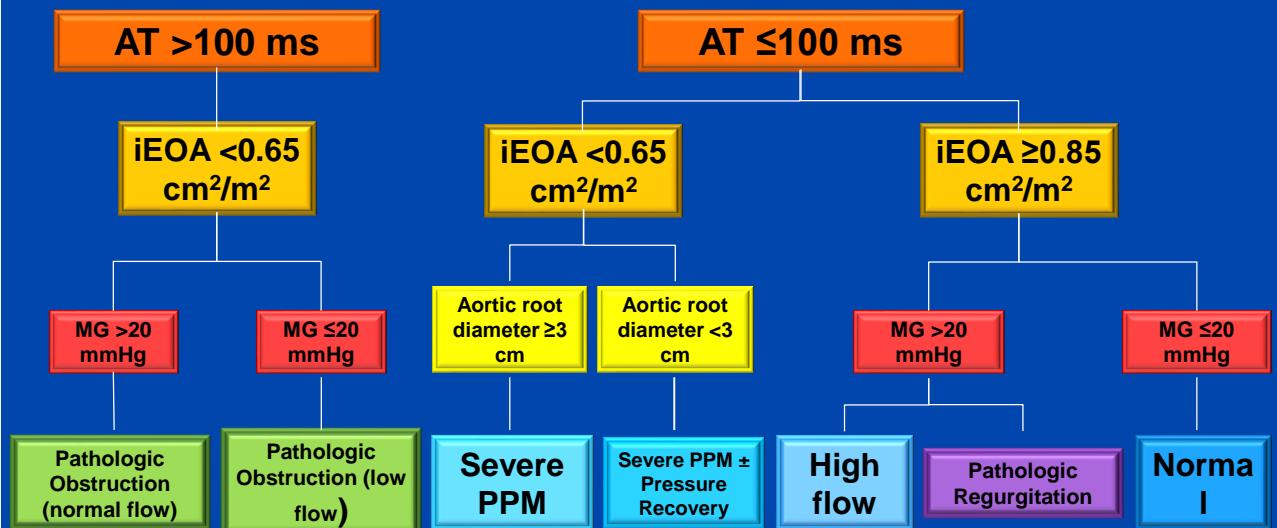


1. Aortic valve replacement
2. Refer to pulmonary
3. Exercise test
4. TEE
5. Old age and Observe



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Pericardial Aortic Prosthesis



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Exercise Cardiac Catheterization PPM + Pressure Recovery



Rest

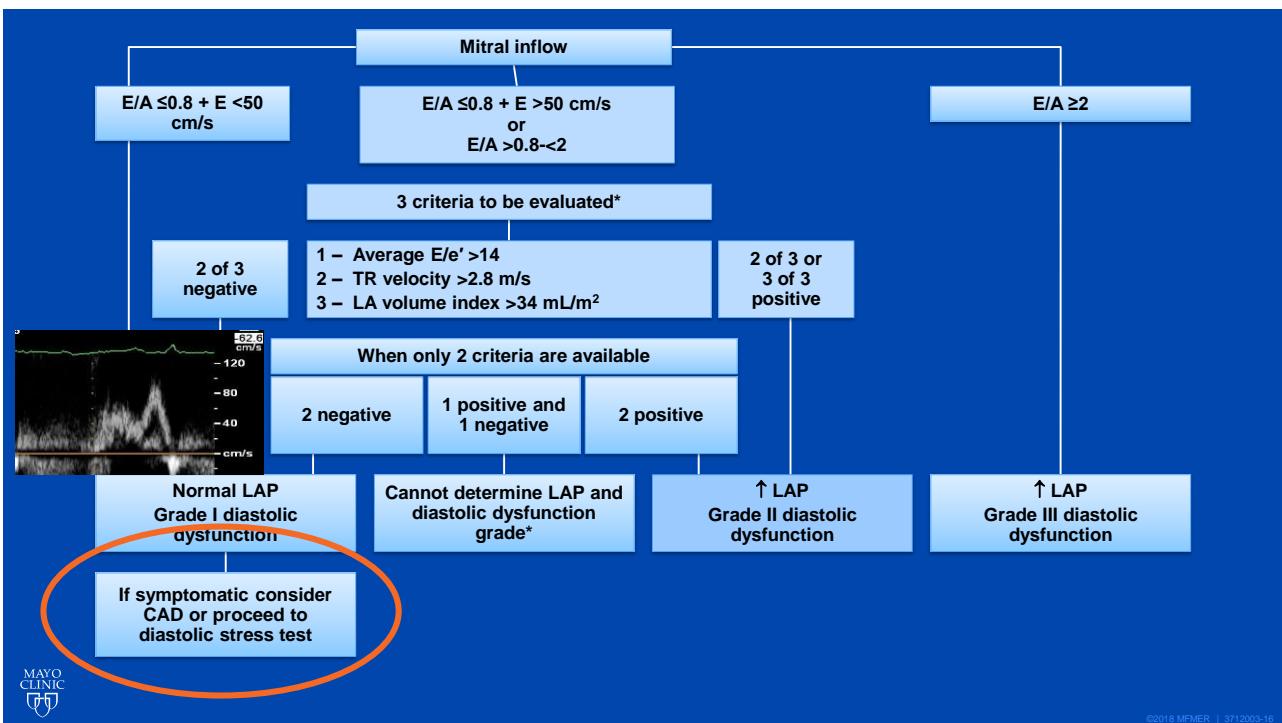
LVEDP 12, PAWP 8
CO 2.8, CI 1.5, MG 17 mmHg
AVA 1.1 cm²



Exercise

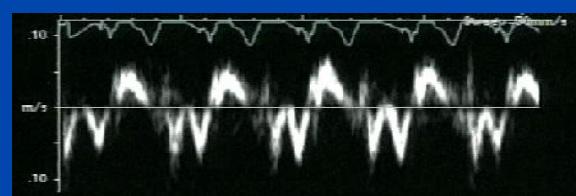
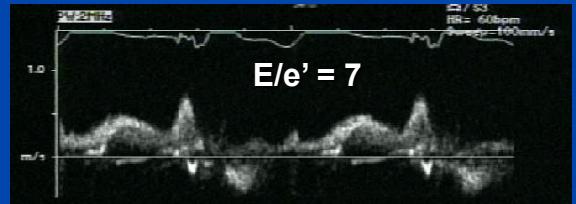
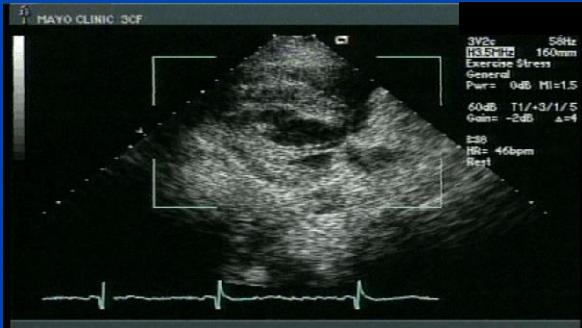
PAWP 41, LVEDP 44, mean PA 46
Aortic pressure 220
CO 5.7, CI 3.1, gradient 10, AVA 2.0 cm²

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73 yo woman with Hypertension and Exertional Dyspnea
No ischemia

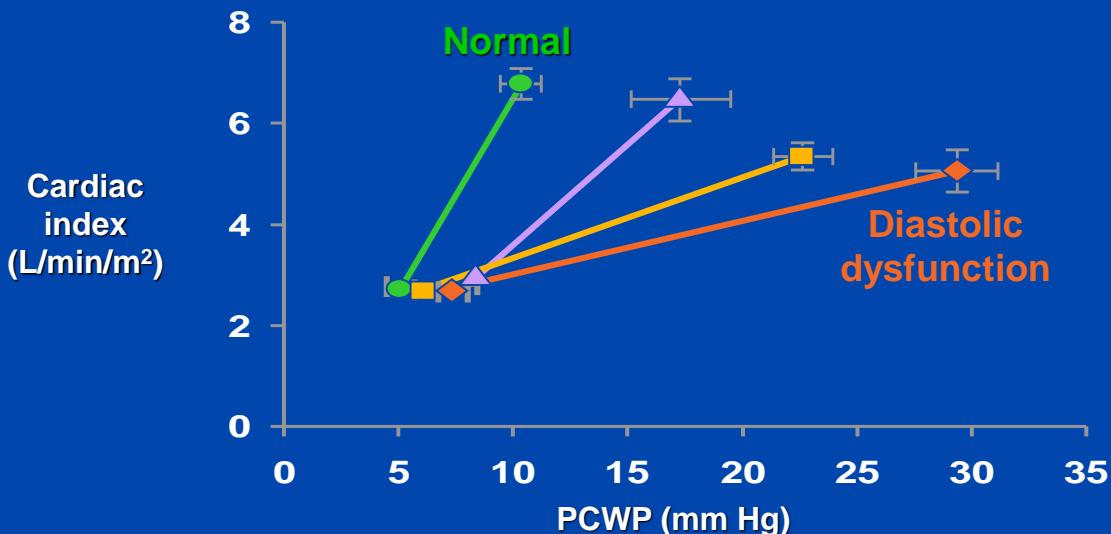


"This patient has delayed myocardial relaxation, but filling pressure is not increased at rest"



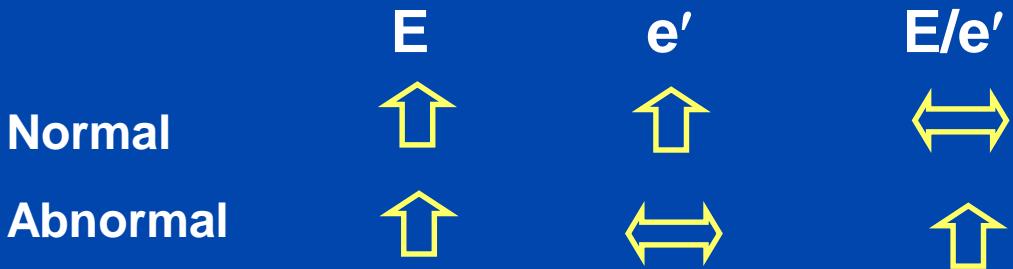
CP1082496-6 | 5/8/2018
©2018 MFMER | 3712003-17

Change in CI and PCWP with Exercise Normal and Abnormal Diastolic Function



CP1082496-59 | 5/8/2018
©2018 MFMER | 3712003-17

Dynamic Diastology Filling Pressure (E/e') with Exercise



LV filling pressure (E/e') does not increase much with exercise in normal heart, but increases in symptomatic patients with diastolic dysfunction.



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Diastolic Stress Test *Baseline and Peak (or Post) Exercise*

- Supine bike or Treadmill
- 25 watts (3 min) increments
- Assess LVEF, size, and wall motion
- Mitral inflow (E, A, and DT)
- Mitral annulus velocity
- E/e' ratio
- TR velocity



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Effects of Treadmill Exercise on Mitral Inflow and Annular Velocities in Healthy Adults

Jong-Won Ha, MD, PhD, Fabijan Lulic, MD, Kent R. Bailey, PhD, Patricia A. Pellikka, MD, James B. Seward, MD, A. Jamil Tajik, MD, and Jae K. Oh, MD

	Baseline	Exercise
E (cm/s)	73±19	90±25
A (cm/s)	69±17	87±22
DT (ms)	192±40	176±42
e' (cm/s)	12±4	15±5
E/e'	6.7±2.2	6.6±2.5

Mean age 59±14 yrs

Ha J et al: AJC, 2003

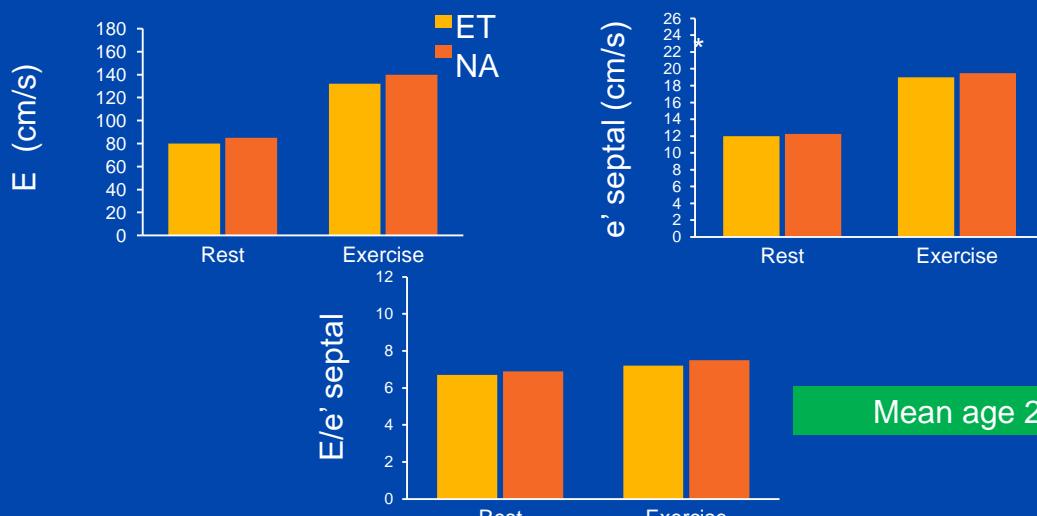
©2018 MFMER | 3712003-24



LV Diastolic Function at Rest and With Stress

Diastolic Stress Echocardiography in the Young:
Endurance-Trained (ET) Healthy Subjects

Nonathletic (NA) and



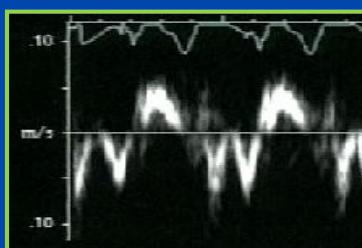
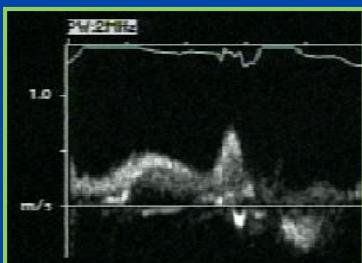
Mean age 29 yrs



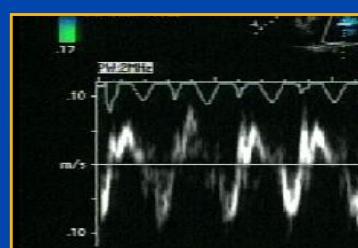
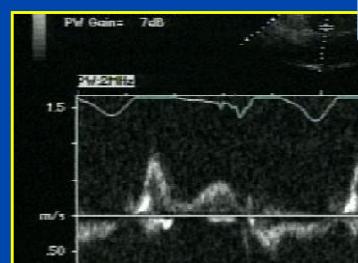
Bruengger et al: JASE, 2014

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Exertional Dyspnea



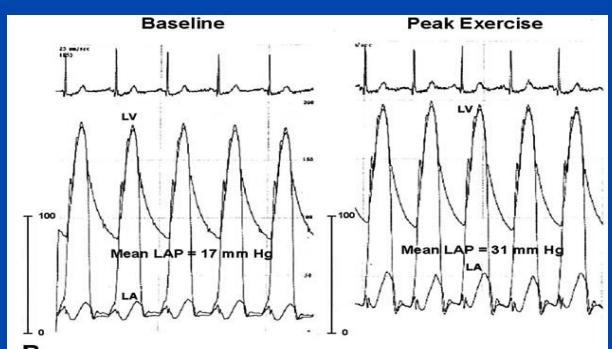
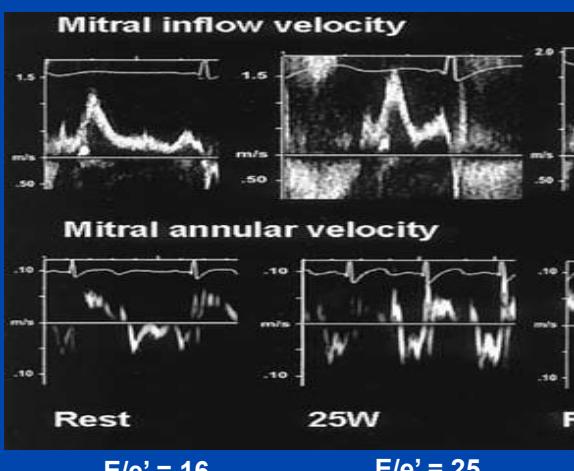
Baseline



Supine Bike

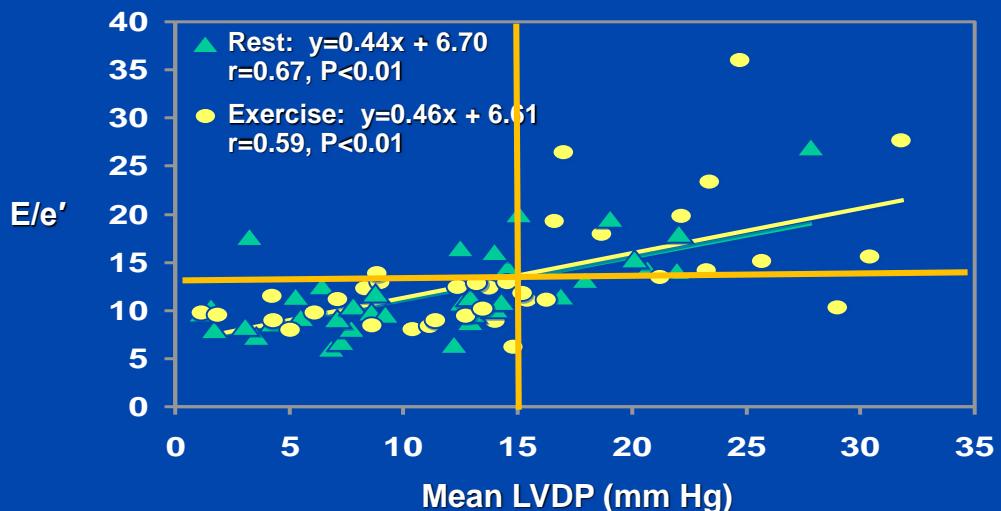
CP1082496-6 | 5/8/2018
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Echo-Cath Correlation



Ha et al. JASE 2005

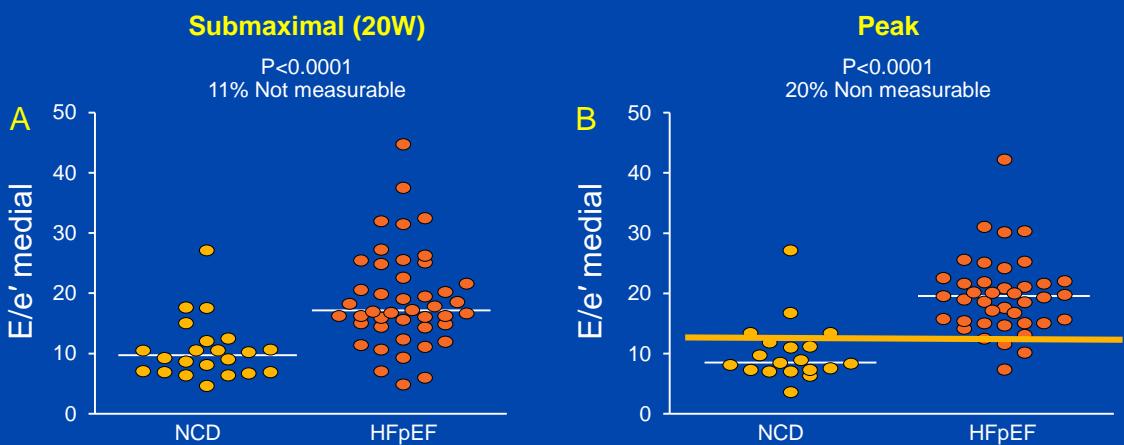
Mean LVDP vs E/e' Rest and Exercise



Burgess et al: JACC 47:1891, 2006

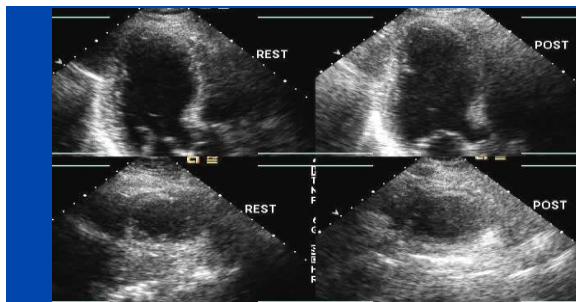
©2018 MFMER | 3712003-25

Echocardiographic Hemodynamic and Ventricular Function Indices During Exercise

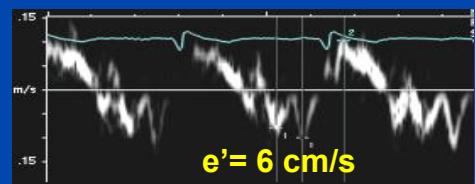
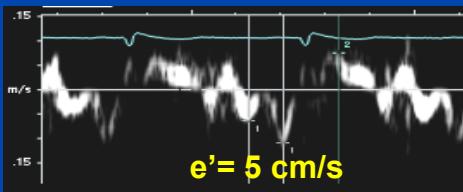
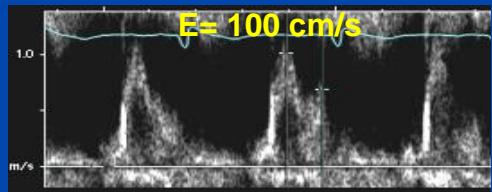
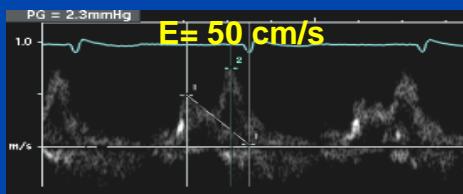


Obokata M et al: Circ 135:825-838, 2017

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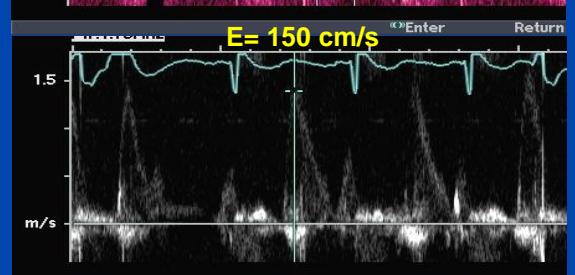
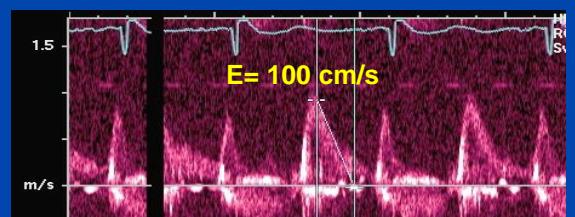
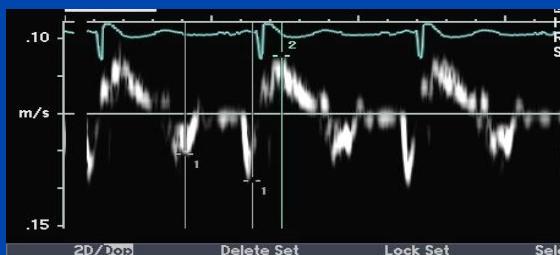
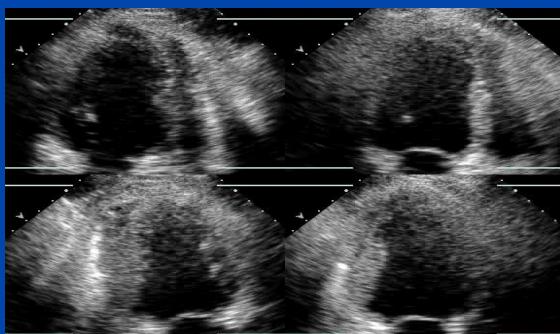
Exercise Echo for Dyspnea



MAYO CLINIC

5/8/2018
MFMER | 3712003-27

Exercise Echo for Dyspnea



MAYO CLINIC

5/8/2018
MFMER | 3712003-28

Which of following clinical situation is best suited for using E/A ratio as the initial diastolic assessment parameter?

Question #4

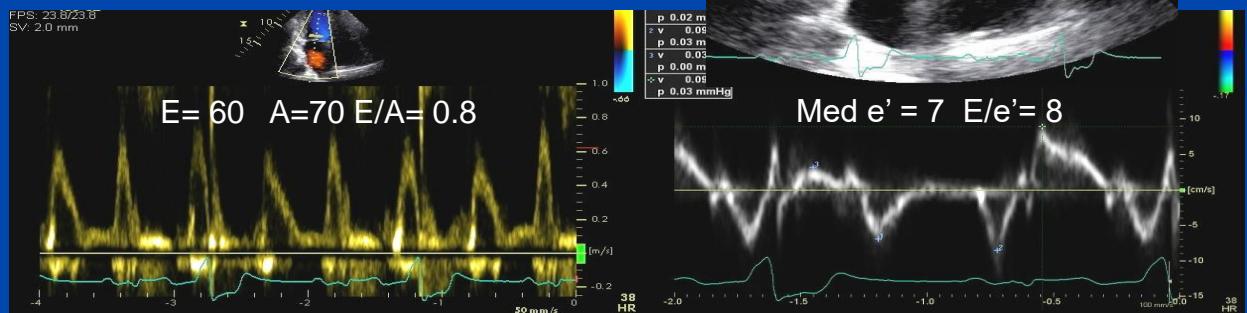
1. Age > 80 years
2. Uncontrolled hypertension
3. LVEF 45%
4. AL Cardiac Amyloidosis
5. Hypertrophic cardiomyopathy
6. Marked mitral annulus calcification



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Question #5

79 year old with bigemini

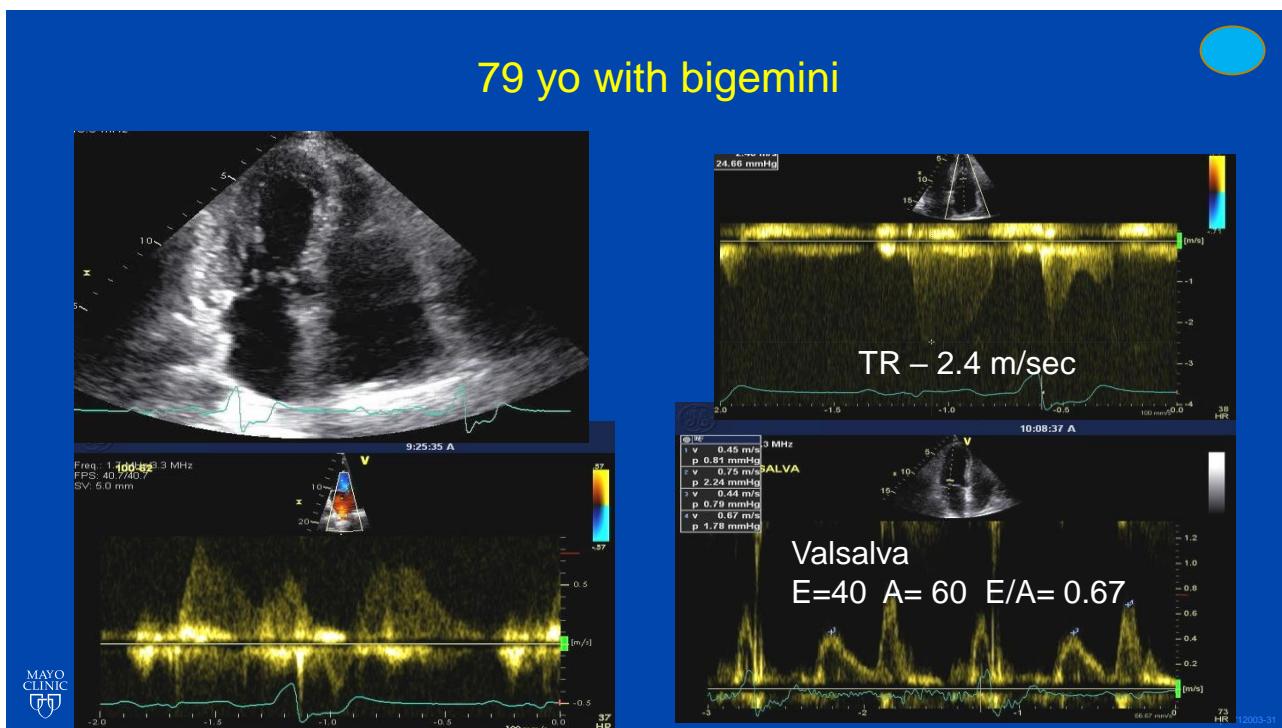


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate

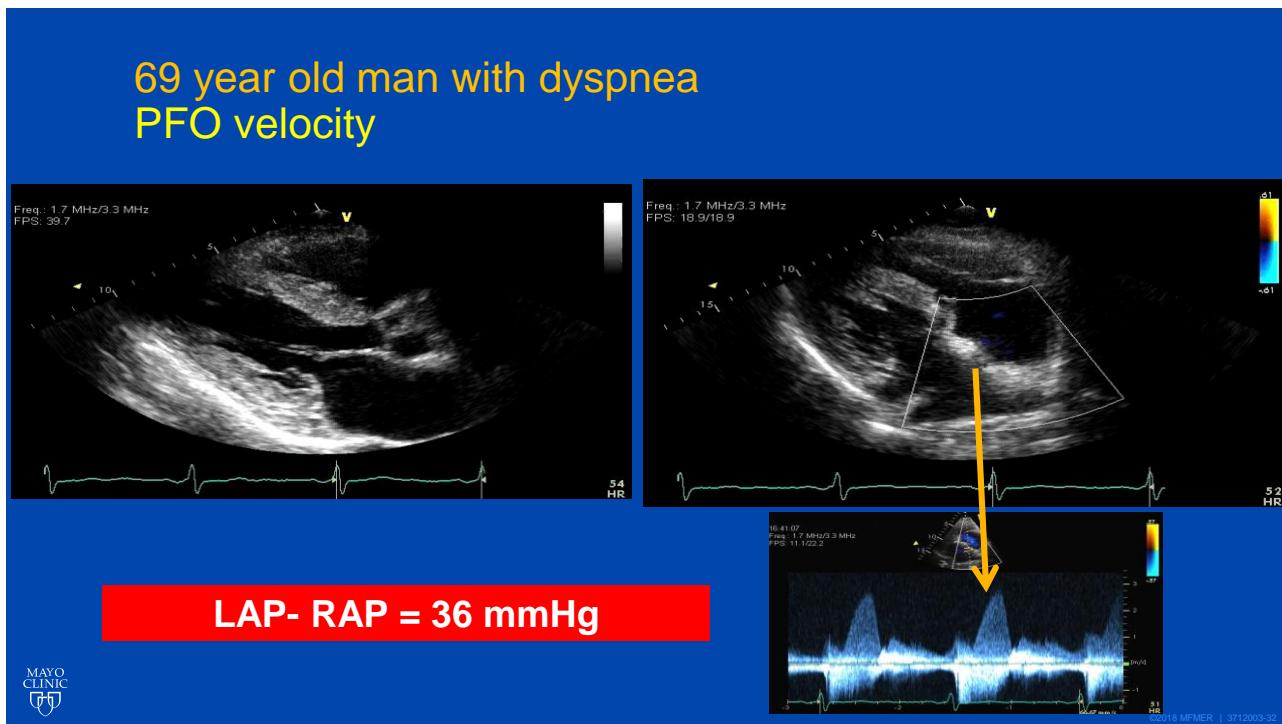


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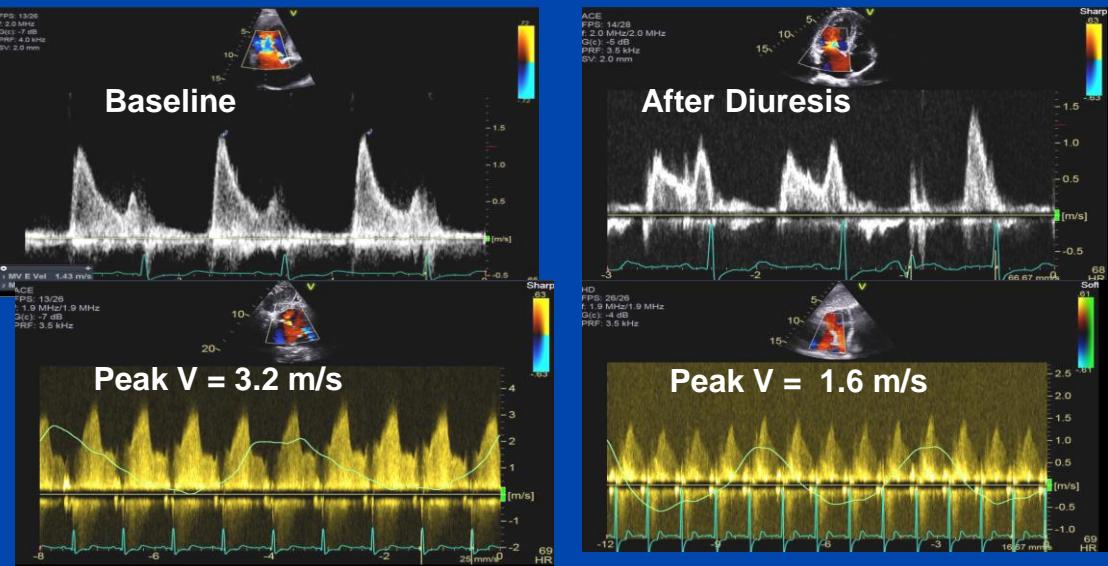
79 yo with bigemini



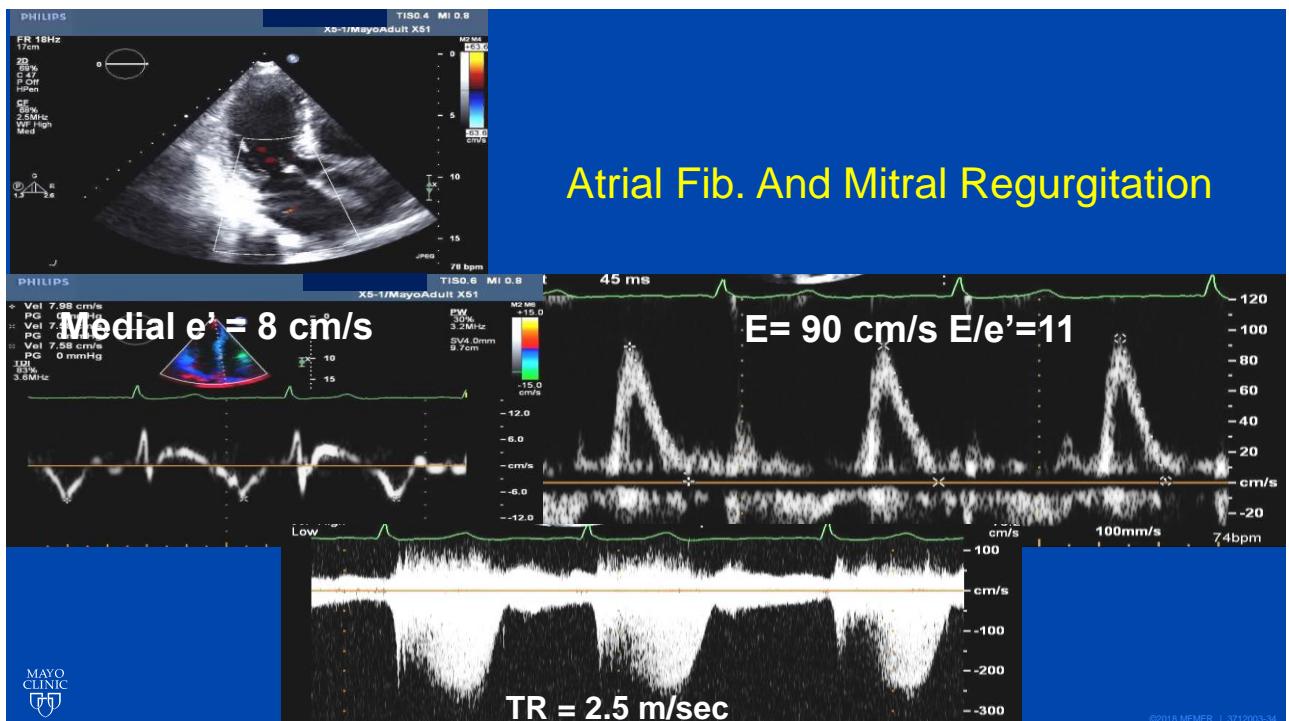
69 year old man with dyspnea
PFO velocity



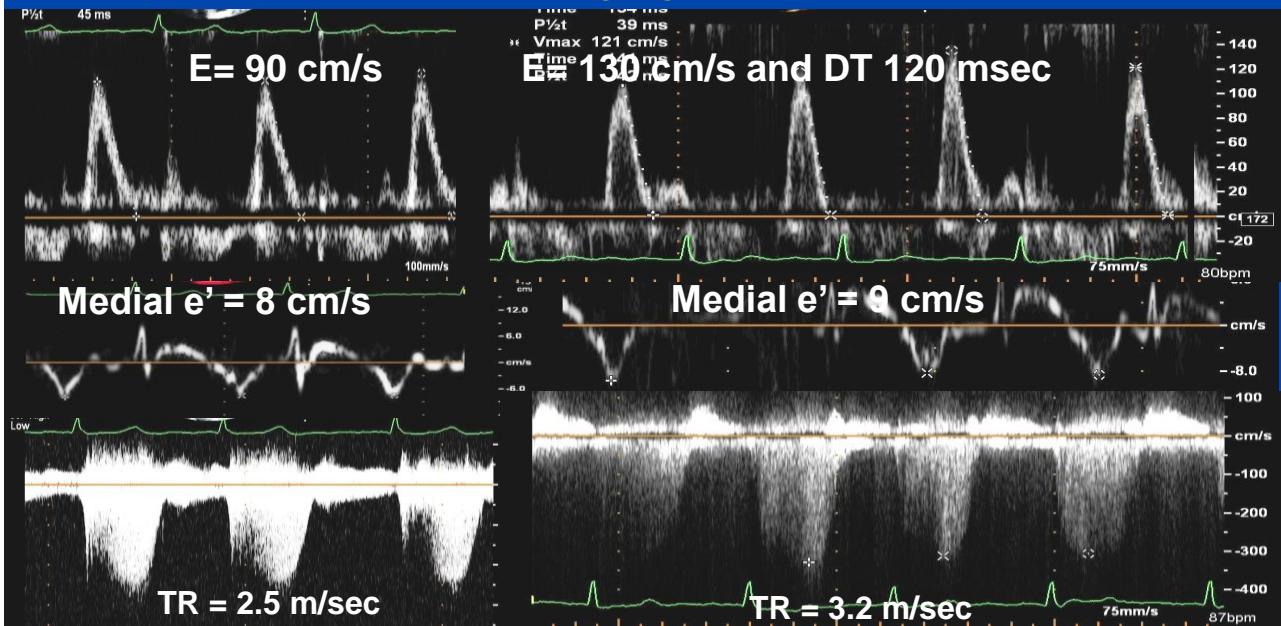
PFO Velocity for estimating LA pressure



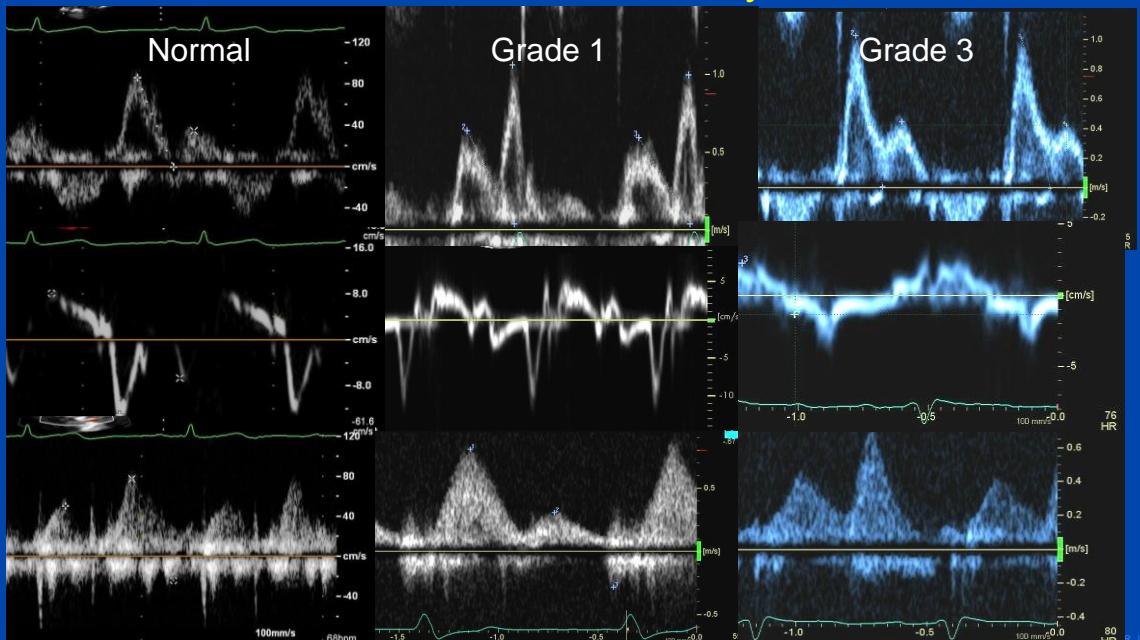
From Chandra, MD & Will Miranda, MD



Atrial Fib. And Mitral Regurgitation with exercise



Mitral E, e' and Pulmonary Vein





Questions & Discussion

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Pericardial Diseases Questions



Jae K. Oh, MD

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Question #6

Who from following patients has the highest medial e' velocity expected?

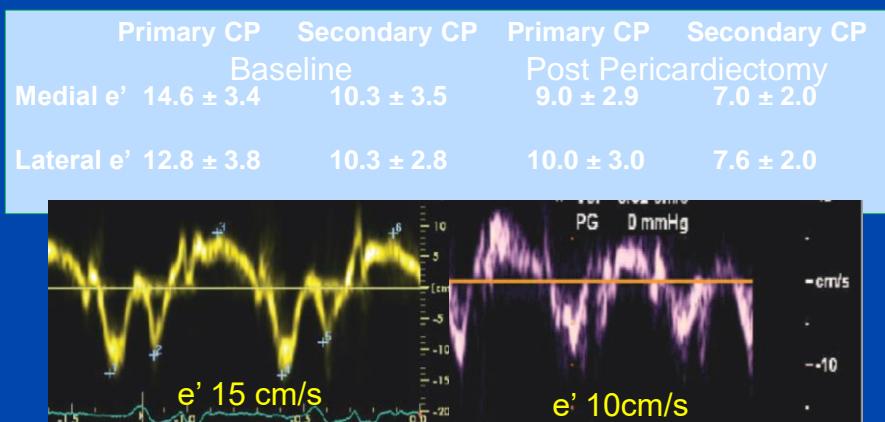
1. 35 year old woman with CP after radiation treatment
2. 65 year old woman with CP after viral illness
3. 55 year old man with CP after CABG
4. 45 year old man with cardiac Fabry's
5. 75 year old woman with HFPEF



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Mitral and Tricuspid Annular Velocities Before and After Pericardectomy in Patients With Constrictive Pericarditis

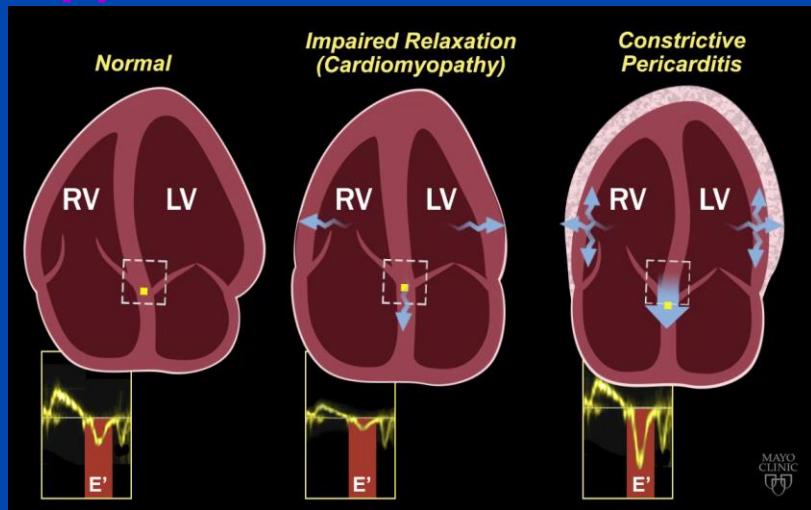
Gabriella Veress, MD; Lieng H. Ling, MD; Kye-Hun Kim, MD, PhD; Jacob P. Dal-Bianco, MD; Hartzell V. Schaff, MD; Raul E. Espinosa, MD; Rowlens M. Melduni, MD; Jamil A. Tajik, MD; Thoralf M. Sundt, III, MD; Jae K. Oh, MD



Veress et al. Circulation CV Imaging July 2011

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Tissue Doppler in Constriction vs Restriction



E' normal to high in constriction, low in myocardial disease

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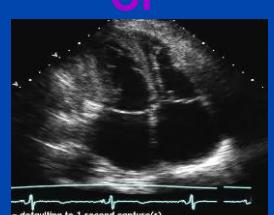
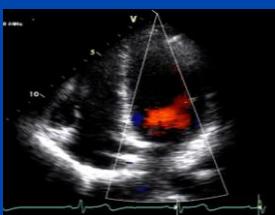
Normal vs RCM vs CP

Medial Mitral e' velocity (LV Relaxation)

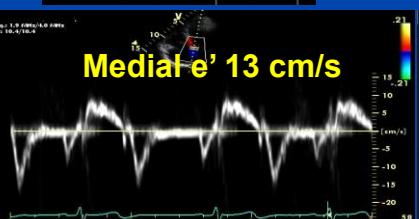
Normal

RCM

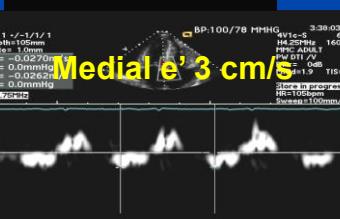
CP



Medial e' 13 cm/s



Medial e' 3 cm/s



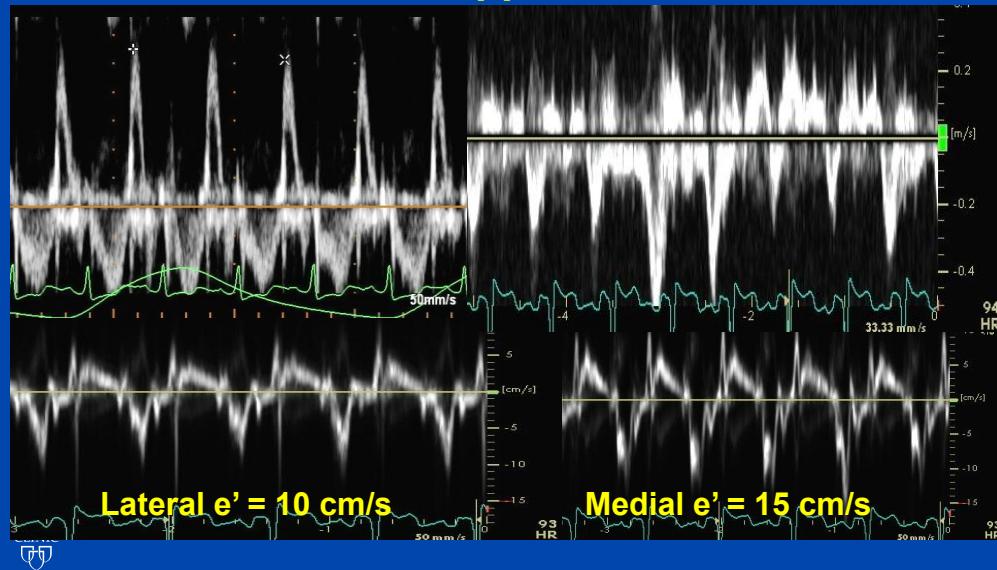
Medial e' 14 cm/s
Usually > Lateral e'
(Annulus Reversus)



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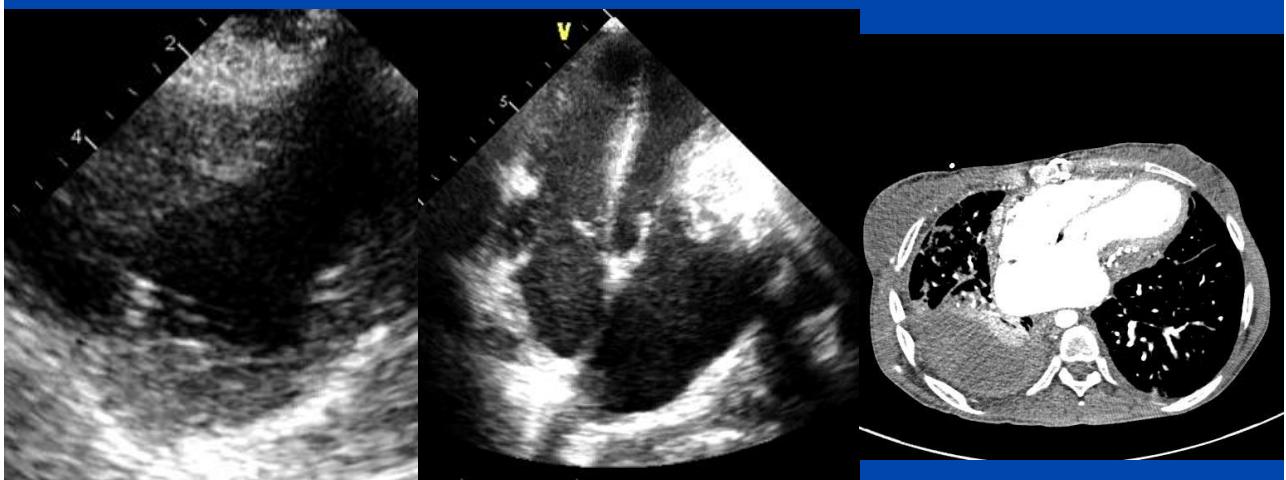
Question
#7

A 26 year old woman with a previous pericardectomy, for tbc CP presenting with edema Doppler demonstrates ?



1. Recurrent CP
2. Normal
3. Restriction
4. Respiratory distress

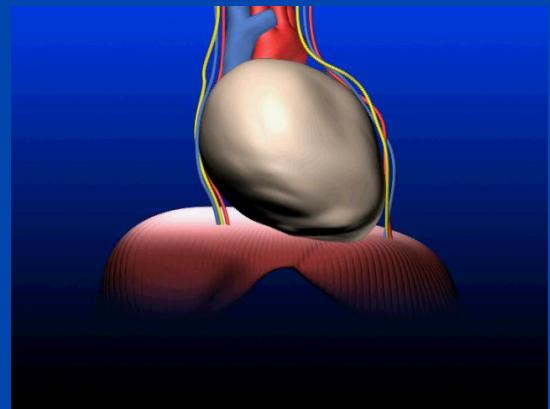
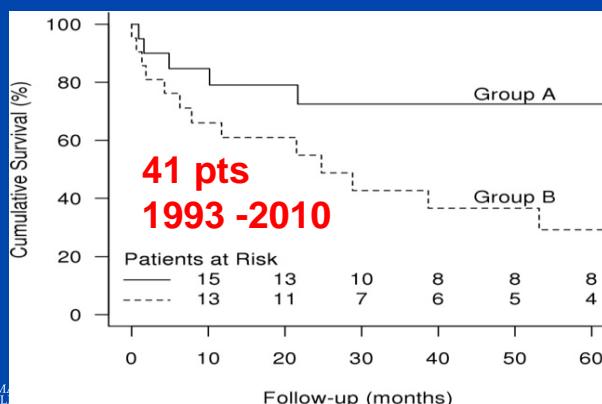
A 26 year old woman with a previous pericardectomy, presenting with edema



Completion Pericardectomy for Recurrent Constrictive Pericarditis: Importance of Timing of Recurrence on Late Clinical Outcome of Operation

Yang Hyun Cho, MD, Hartzell V. Schaff, MD, Joseph A. Dearani, MD,
Richard C. Daly, MD, Soon J. Park, MD, Zhuo Li, MS, and Jae K. Oh, MD

Division of Cardiovascular Surgery, Division of Biomedical Statistics and Informatics, and Division of Cardiovascular Disease,
Mayo Clinic, Rochester, Minnesota

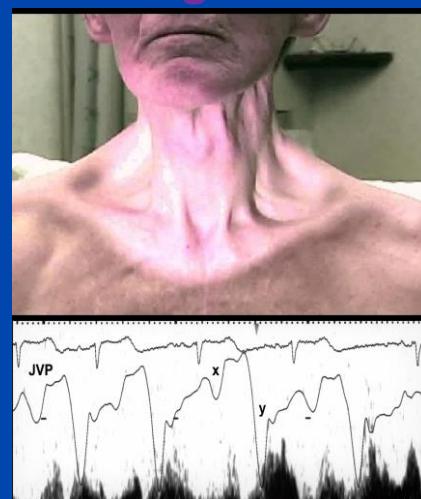


Cho and Schaff et al. Annal Thorac Surgery 2012 | 3949-45



Question #8

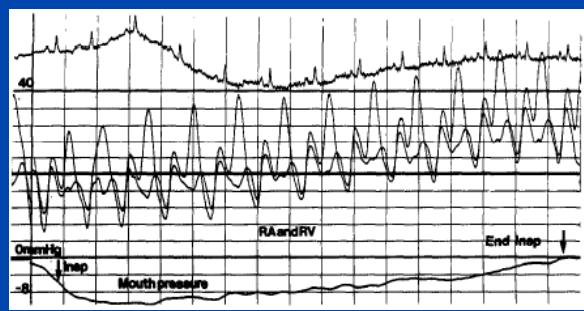
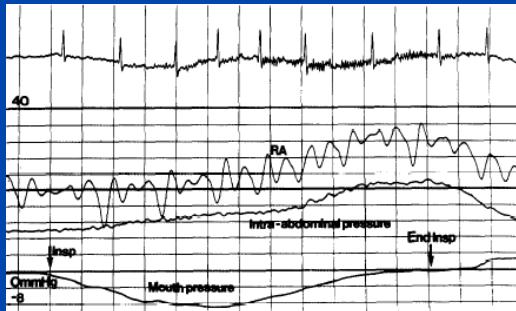
1. Expiratory increase in JVP
2. Cannot be correct since opposite to Hepatic Vein
3. Due to increased IVC flow



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Mechanism Underlying Kussmaul's Sign in Chronic Constrictive Pericarditis

Theo E. Meyer, MB, FCP (SA), Pinhas Sareli, MD, Richard H. Marcus, MB, FCP (SA), Wendy Pocock, MB, FRCP, Martin R. Berk, MB, FCP (SA), and Maurice McGregor, MD



T Meyer AJC 1989

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Question #9

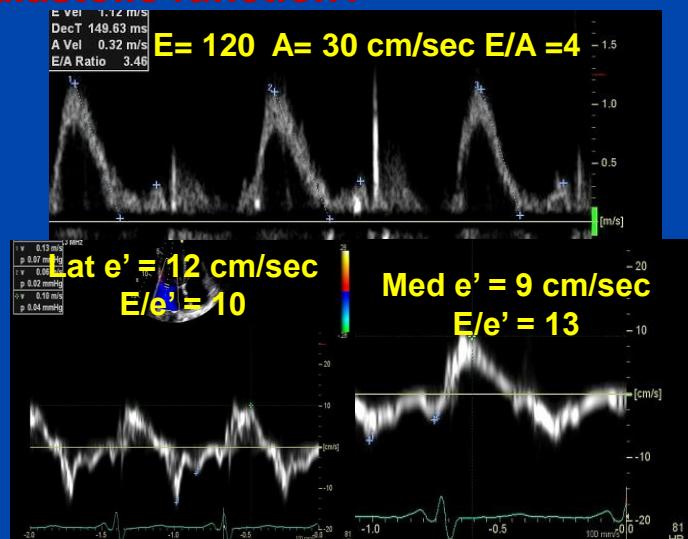
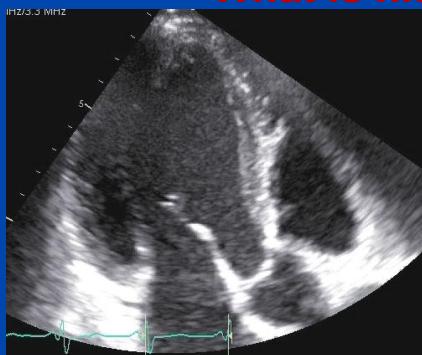
42 year old man with dyspnea

- Gradual onset of chest tightness and dyspnea
- Physical Examination
 - HR 90 BPM
 - JVP mildly elevated
 - Increased S2 intensity
 - GR 1/6 systolic murmur
 - Mild pitting edema



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42 year old man with dyspnea
What is his diastolic function?



1= Grade 1 2= Grade 2

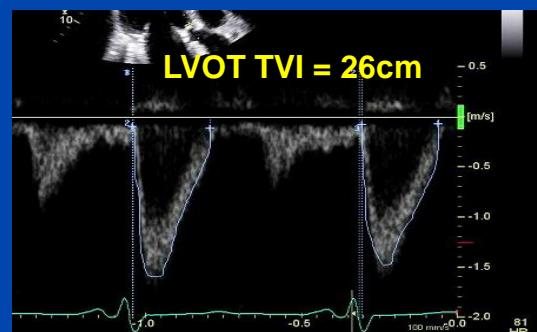
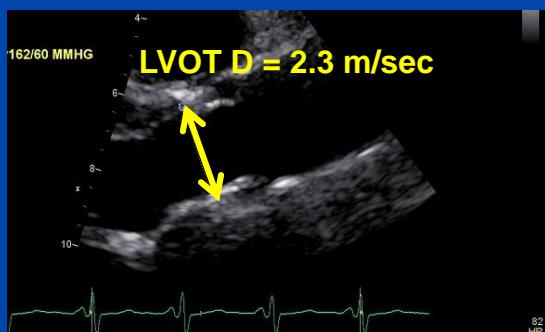
3= Grade 3 4= Normal

5= Constriction



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42 year old man with dyspnea and high output



$$SV = (2.3)^2 \times 0.785 \times 26 = 108 \text{ mL}$$

$$CO = SV \times HR = 108 \times 80 = 8.6 \text{ L}$$

$$CI = CO/BSA = 8.6 / 1.93 = 4.48 \text{ L/m}^2$$



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What is the most common cause of HF seen in this 42 year old man?

$$SV = (2.3)^2 \times 0.785 \times 26 = 108 \text{ mL}$$

$$CO = SV \times HR = 108 \times 80 = 8.6 \text{ L}$$

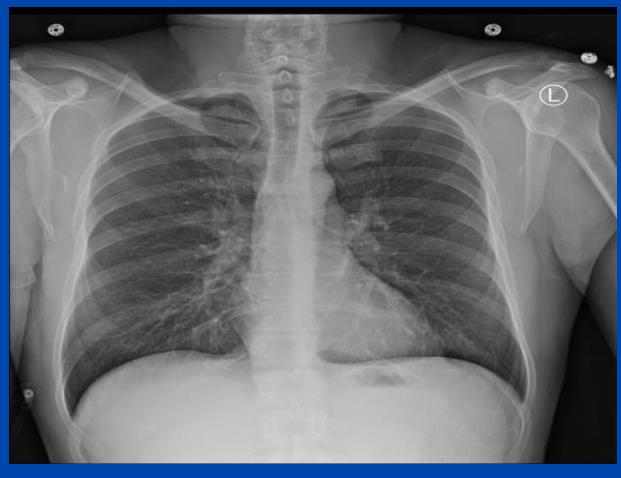
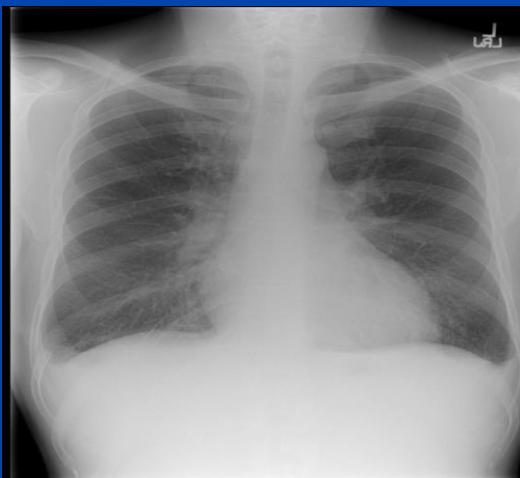
$$CI = CO/BSA = 8.6 / 1.93 = 4.48 \text{ L/m}^2$$

1. Shunt
2. Obesity
3. Liver Disease
4. Pheochromocytoma



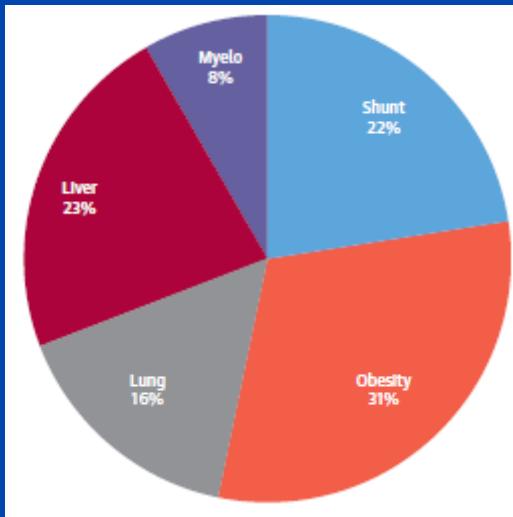
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42 year old man with high output HF
Before and after treatment (Thyrotoxicosis)



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Etiologies of High Output Failure Cardiac Index > 4.0 L/m²

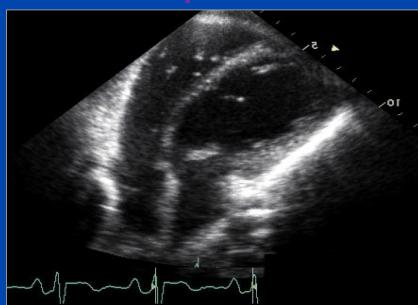


- Obesity (31%)
- Liver Disease (23%)
- Shunt (22%)
- Diastolic function can be normal

Reddy et al JACC 2017

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47 year old man with chest pain
What is your next step?

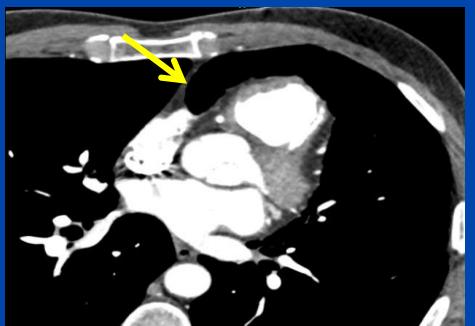
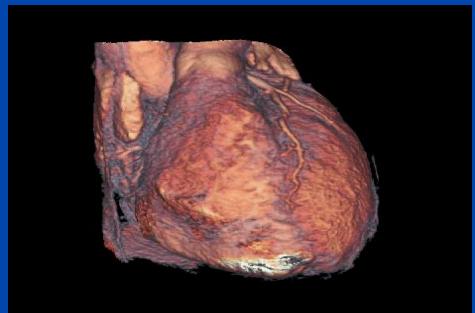


1. Cardiac Cath
2. TEE
3. CT
4. Stress Echo

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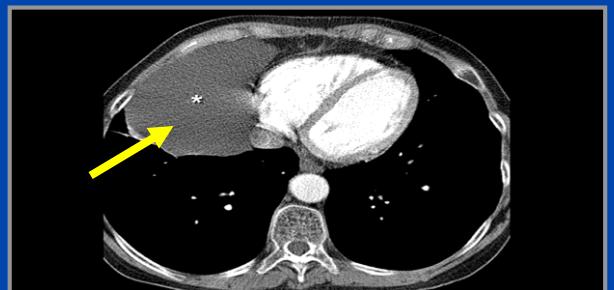
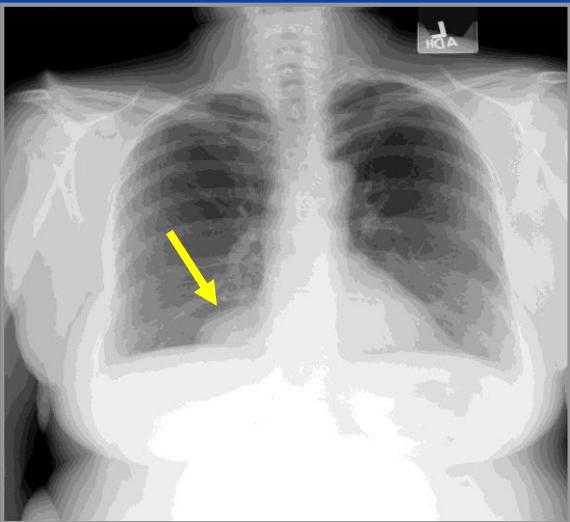
Congenital Absence of the Pericardium



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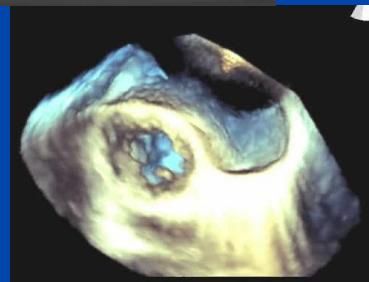
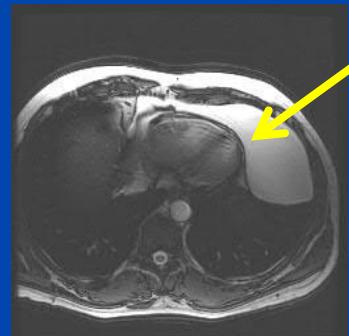
Pericardial Cyst



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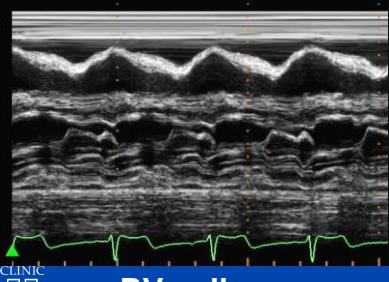
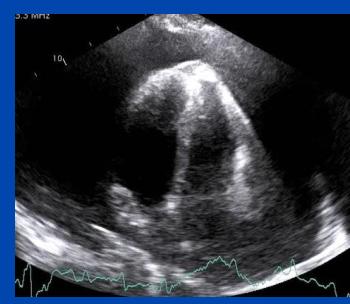
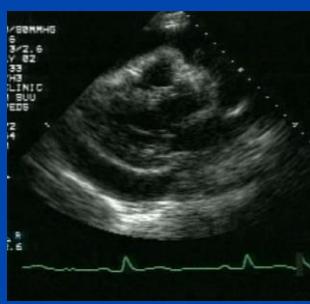
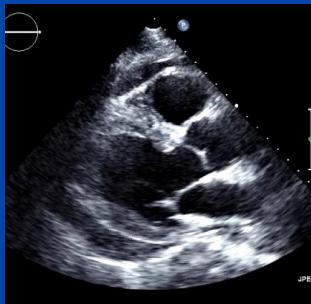
A large pericardial cyst



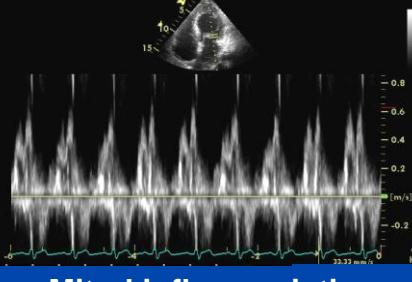
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3712003-57

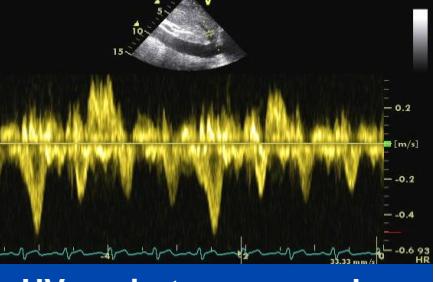
Cardiac Tamponade



RV collapse



Mitral inflow variation

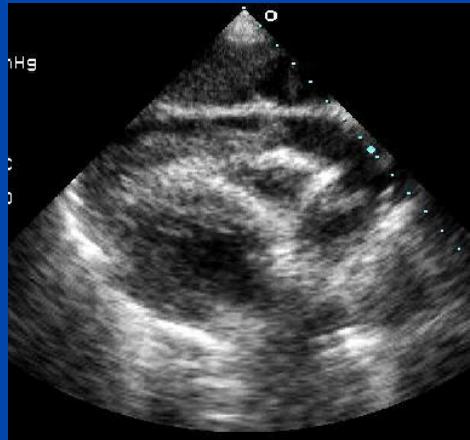


HV expiratory reversal

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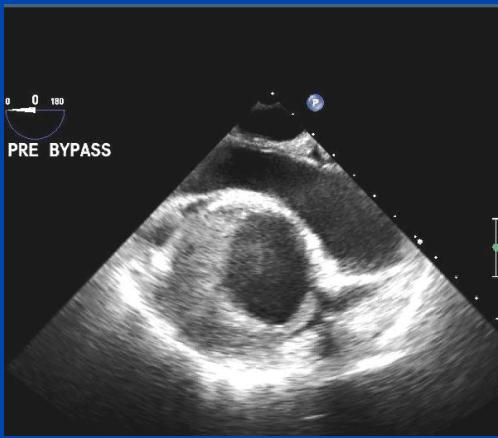
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Hemo-pericardium

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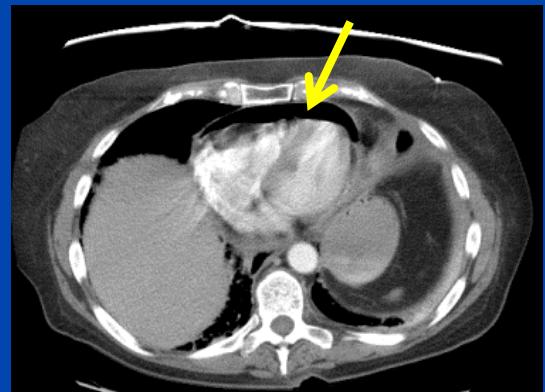
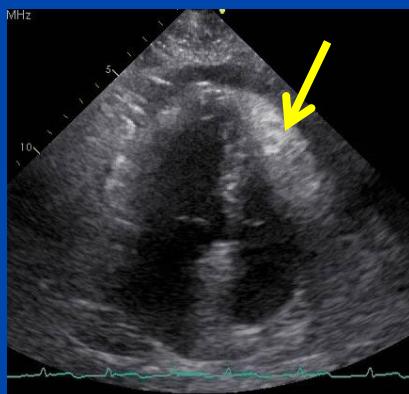
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Intramural Hematoma

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**66 year old woman with dyspnea
Pneumo-pericardium**



PneGastro-pericardial fistulau



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23 year old woman from Middle East with ascites several month after acute pericarditis and pericardial effusion



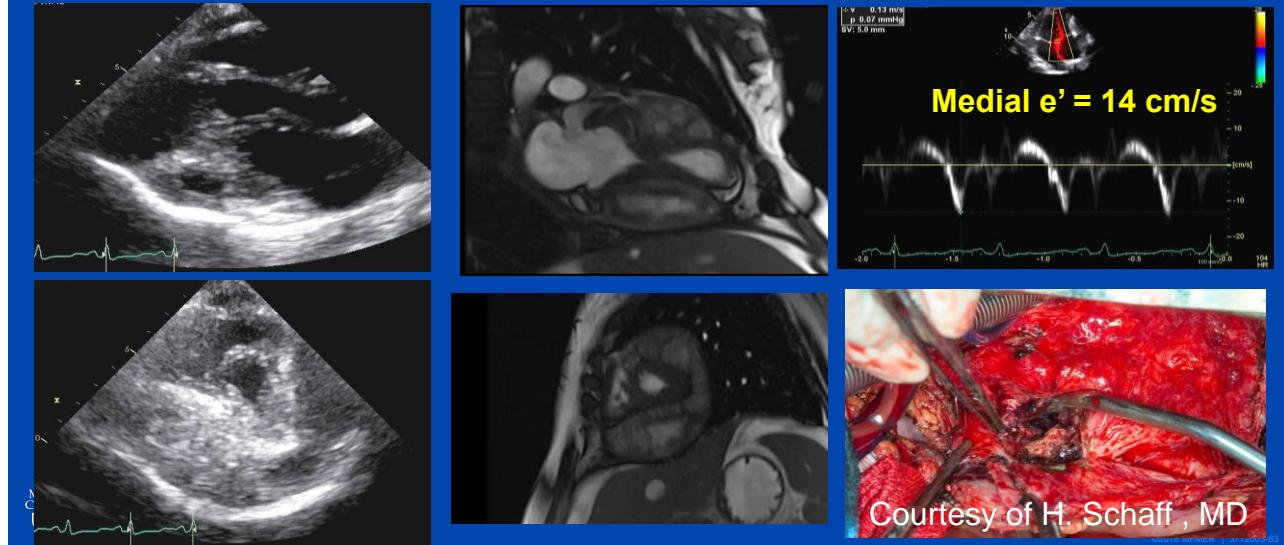
Medial $e' = 14 \text{ cm/s}$

Lateral $e' = 11 \text{ cm/s}$

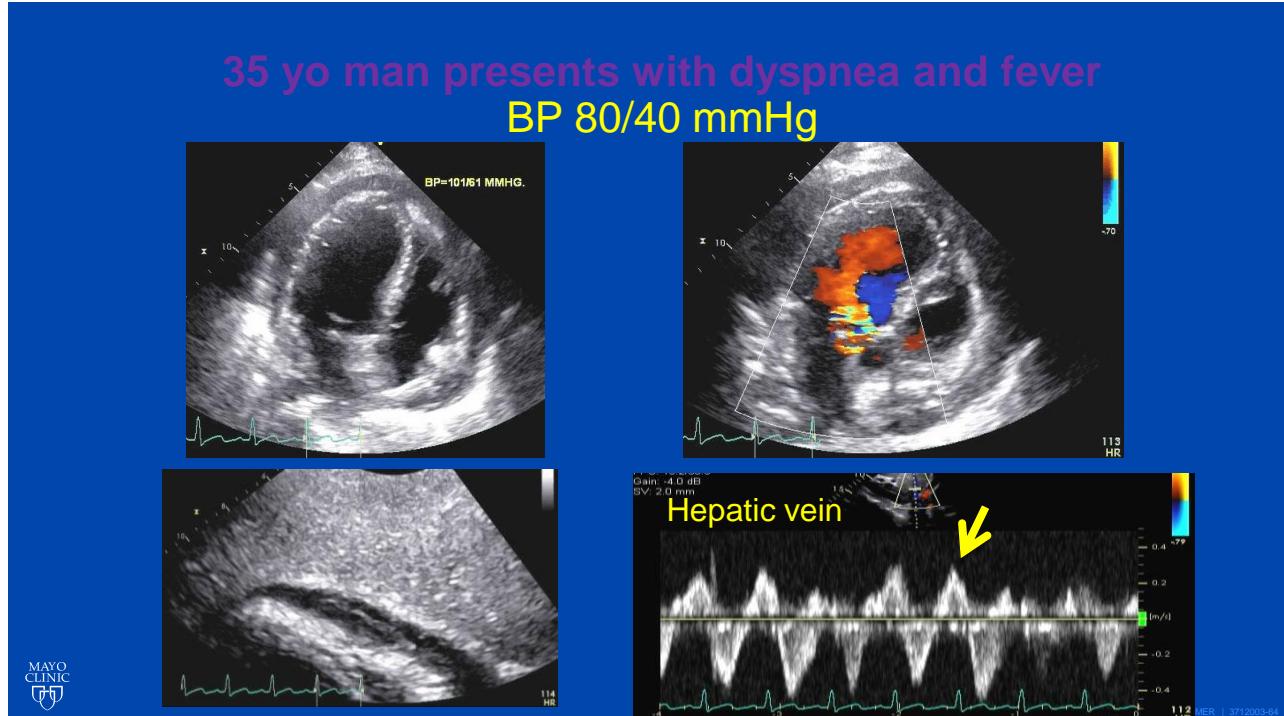


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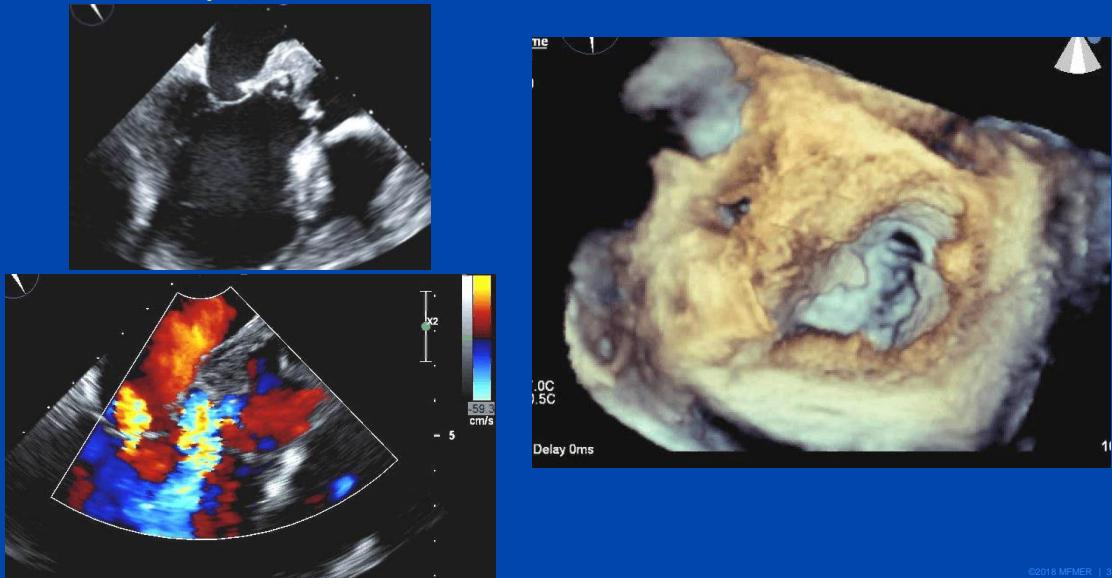
23 year old woman from Middle East with ascites several month after acute pericarditis and pericardial effusion (Thrombotic CP)



**35 yo man presents with dyspnea and fever
BP 80/40 mmHg**



**35 yo man with tamponade and fever
TEE after pericardiocentesis**



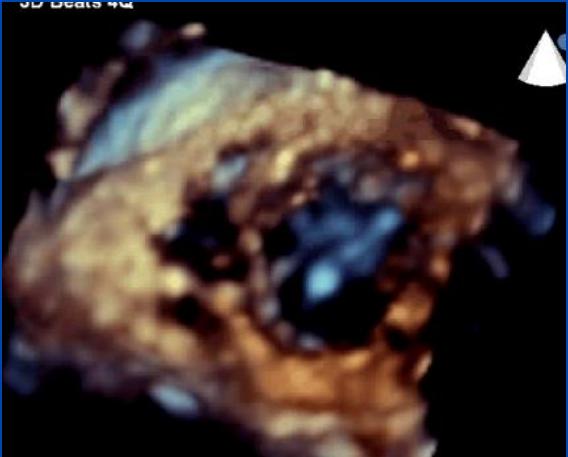
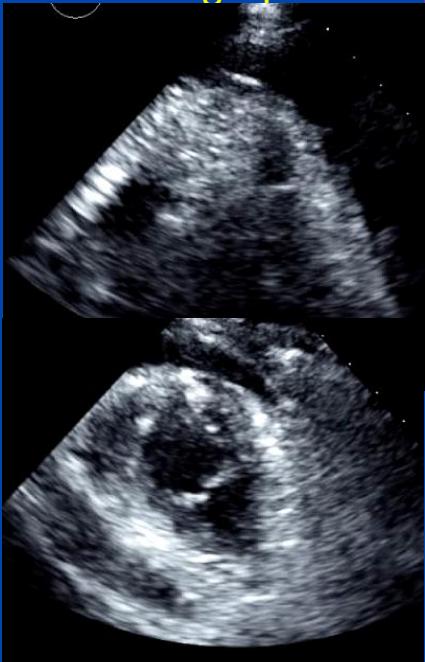
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**Final Pericardial Disease Case
45 yo male with chest pain x 4 days**

- Pain preceded by heavy lifting while camping. No relationship to exercise.
- MVA with pelvic and rib fractures. Chest tube and IVC filter placement 6 yrs ago.
- Many CV risk factors

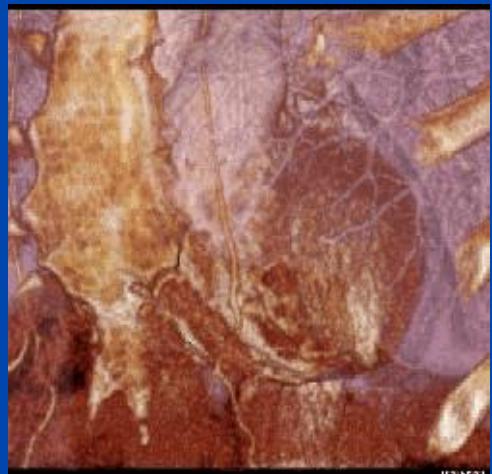
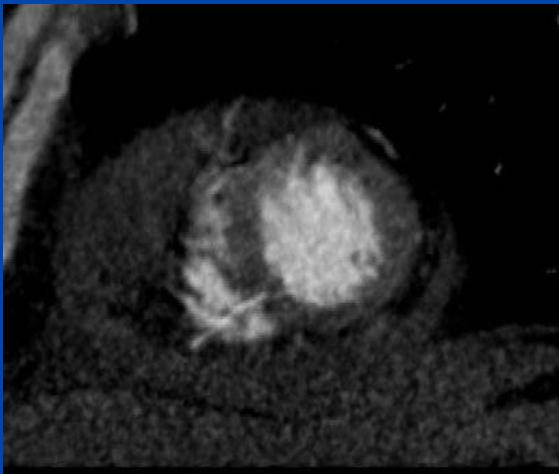


Echocardiographic images in 45 yo with chest pain

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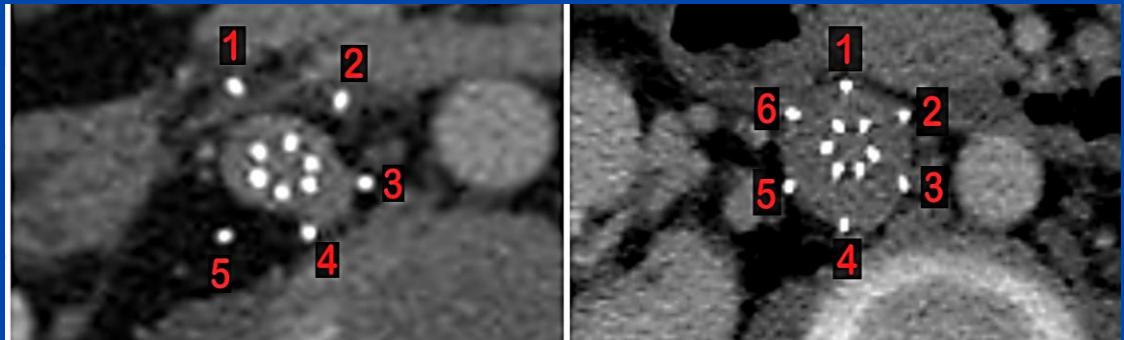
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Chest and Cardiac CT

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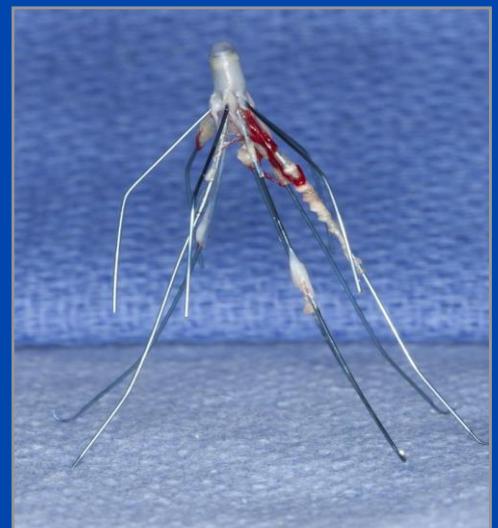
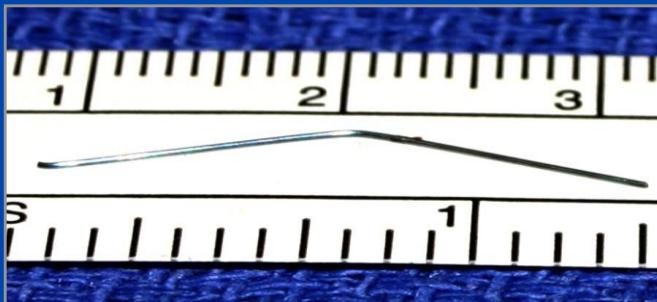
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CT scans now and 8 years ago

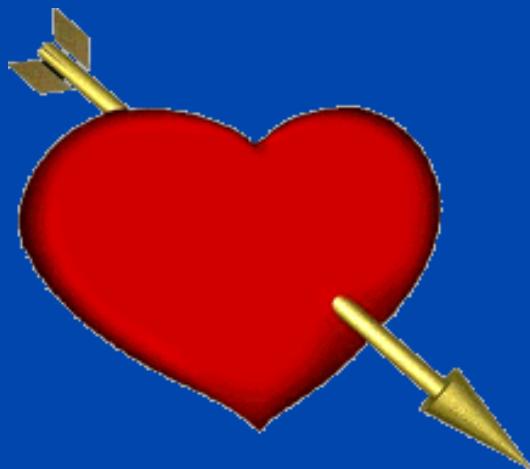


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Embolic strut from IVC Filter

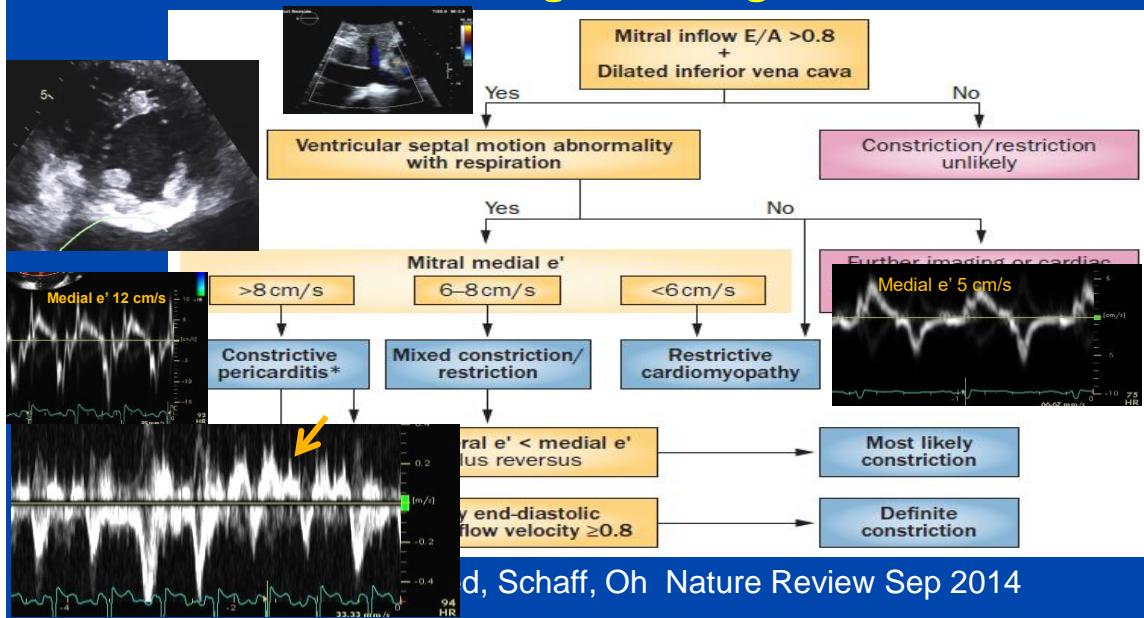


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Constriction or Myocardial Disease ? Diagnostic Algorithm



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Thank You !

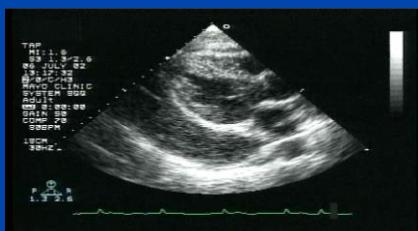
Oh.jae@mayo.edu

Jaekuen.oh@samsung.com



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Echo-Guided Pericardiocentesis



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Questions & Discussion

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